LESSON TIME FOR A CHANGE

About this Activity

Students will develop a time line relating technological advances, particularly in microscopy, to changes made in how scientists classified living organisms throughout history. Students will utilize internet and/or library research to investigate important discoveries in biology, and their links to these advances. The time line will range from Aristotle's two-kingdom system of classification, to the system of using three domains of life, which is currently favored by a number of scientists.

Background

People often have a tendency to look at life through a narrow focus and sometimes think of the universe as revolving around them. The truth of the matter is, however, that humans comprise a very small twig at the end of the farthest branch on the "tree of life". In order for students to be able to visualize their place in the scheme of life, it is necessary for them to develop an understanding of the methods that have been used to classify living things throughout history. They should realize that classification is not static, but changes with our level of knowledge.

The invention of the microscope focused attention on the existence of life beyond what was previously known. Scientists became aware of the inadequacy of the classification system in use at that time. On a larger scale, for many years giant pandas were considered to be bears. Discovery of the red panda shifted opinions toward a possible relationship between the pandas and raccoons. Recently, however, the advent of DNA technology has turned the tide of opinion, and pandas are once again thought to be cousins of the bear.

Research begun in 1977 by Dr. Carl Woese, University of Illinois, led him to propose an entirely new level of classification, higher than kingdoms, called **domains**. Dr. Woese proposed that three different domains should be recognized:

- **Eukaryotes**, consisting of all organisms with cells that have true nuclei and membrane-bound organelles – plants and animals fit in this domain
- **Prokaryotes**, have neither nuclei nor organelles with membranes – bacteria fit in this domain
- **Archaea**, are microorganisms similar to bacteria in form but genetically so vastly different from everything else on the planet that they deserve their own unique branch on the tree of life -- some live in acidic conditions, some in boiling hot springs, others deep in the ocean or buried in polar ice.

Often new information or ideas drive further investigation and discovery. The revelation that meteorite ALH84001 is from Mars and the possibility that it might contain fossil evidence of microorganisms motivated many scientists in their study of the earliest evidence of life on Earth. Scientists are now investigating the microorganisms that live in Earth's extreme environments in hopes of understanding how early life arose. This research will help astrobiologists as they search for life in extreme environments on other bodies in our solar system. It may lead to changes in the way information is classified or it may support the existing systems.

Objectives

Students will:

- Infer that science is not static
- Observe that the process of classifying living organisms changes when bio-technology advances

Vocabulary List

domains, Eukaryotes, Prokaryotes, Archaea

Materials

- Reference books, periodicals and/or access to the internet
- 4" X 6" note cards
- two colors of yarn
- Resources (see internet list at the end of this lesson)
- Student Sheet

Procedure

Advanced Preparation

1. Read the background information.
2. Copy Student Sheets one per student
2. Using Teacher Key, chose topics/events and write one on each Student Sheet
3. Attach a length of brightly colored yarn one meter long to a wall. This represents the years of 400 B.C. until the 1500's.
4. A second length of differently colored yarn will be added to the first piece to represent the years between 1500 and the present.
5. Label the first length with the beginning and ending dates.
6. Label the second length with a card placed above the yarn for each one hundred years. Leave a small piece of the second line at the far end, past the last date, and label it The Future? This yarn could be a different color.
7. Make reference/research sources available to students.

Classroom Procedure (for guided discussion)

1. Read the background information to the class.
2. Give each student one of the prepared Student Sheets and a 4" X 6" note card.
3. Explain to students that their sheets have an important event or discovery in biological history. Their task is to use the internet (if available) and other reference materials to find out the date upon which their event occurred, description of the discovery, and its importance. If they are able to access the school, city, county or local university libraries, they will find a much greater range of resources. Internet research is encouraged. (A list of helpful web-sites is included with this activity.) Student Sheets will be turned in to the teacher.
4. Explain that the students will transfer pertinent research information from the Student Sheet to a 4X6 note card. The note cards will be hung from the time line. Encourage the students to be creative with how they share their information.

5. As each student completes his or her research, check it for accuracy. Then he/she may attach the card, along with any associated pictures, into the appropriate spot along the timeline. Students finishing early may select another topic.
6. Discuss the finished timeline with students, encouraging them to infer that changes in classification usually occur after major advances in technology, especially in microscopy.

Extension

Have students speculate as to the technological advances they foresee in the future, new ideas that may force technology development, as well as discoveries that could be made because of those advances. Cards may be added to the end of the timeline depicting those predictions.

TEACHER KEY

GREAT EVENTS IN BIOLOGY

*Indicates events which **must** be included on timeline
Boldfaced type indicates major changes in biological classification

Event	Approximate date of occurrence
***Aristotle creates the first biological classification system**	**330 B.C.**
Printing press invented, allowing better communication of information	1440
*Compound microscope invented	1590 A.D.
Malphigi discovers capillaries	1600
Jan (or Jean) Baptist van Helmont determines that plants requires water	1648
Leewenhoek discovers bacteria	1653
Robert Hook becomes the first person to see cells	1665
Living cells first seen by Anton Von Leeuwenhoek	1668
Francesco Redi disproves spontaneous generation of larger organisms	1668
Classification and study of insects begins with Jan Swammerdam, a Dutch scientist	1669
***John Ray first proposes a definition of what a species is**	1682
John Marshall improves the microscope	1704
*Mirror is added to the microscope by Edmund Culpepper to improve lighting of specimens	1725

*Carrolus Linnaeus establishes new polynomial system of classification	1753
*John Dolland greatly improves resolution of microscope by making better lenses out of a new kind of glass (Flint glass)	1759
Lazzaro Spallanzani researches spontaneous generation	1765-1767
Comparative zoology is founded as a study	1797
Jean Baptiste de Lamarck publishes his theory of evolution	1802 or 1809
*Polarizing microscope invented	1829
Advances made in the microscope	1830
Charles Darwin takes voyage on the HMS Beagle	1831
Cell Theory is proposed by Matthias Schleiden, Theodor Schwann and Rudolf Virchow (these could be three different topics)	1830
Advances made in the microscope by Giovanni Amici	1840
Austrian monk, Gregor Mendel, begins experiments leading to establishment of genetics as a science	1850
Ignatz Semmelweis postulates the use of antisepsis in preventing infection	1850
Charles Darwin's book On the Origin of Species, is published	1859
Louis Pasteur disproves spontaneous generation	1864
Mendel's work finally published	1865
***Ernest Haeckel adds 3rd Kingdom, Protista, to classification system**	1866
Discovery of genetic birth defect,	1866

Down's Syndrome, by J. Langdon Downs	
Robert Kock develops techniques for growing, staining and viewing organisms under the microscope	1873-1876
Advances made in the microscope by Ernst Abbe	1878
Dmitrii Iwanowski discovers the first virus, the tobacco mosaic virus	1892
Walter Sutton discovers chromosomes are paired and perhaps carriers of heredity	1902
Thomas Hunt Morgan, using fruit flies, proves chromosomes & heredity linked	1907
Godfred Hardy & Wilhelm Weinberg determine an equilibrium formula for a population, assessing the effects of mutation (Hardy-Weinberg Principle)	1908
Thomas Hunt Morgan discovers that genes are carried on chromosomes	1910
Luther Burbank publishes work in plant hybridization	1921
Thomas Hunt Morgan publishes gene theory	1926
Hermann J Muller uses x-rays to produce gene mutations	1927
Alexander Fleming discovers penicillin	1928
*Ernst Ruska and Rheinhold Ruedenberg invent the Transmission Electron Microscope	1931
First electron microscope commercially sold in England	1935
Albert Claude studies cells with electron microscope and discovers endoplasmic reticulum and details of mitochondria	1935
Alexander Oparin forms hypothesis on conditions necessary to origin of life	1936

Eduard Chatton establishes the difference between prokaryotes & eukaryotes	1937
***Herbert Copeland adds 4th Kingdom, Monera**	1938
Vladimir Zworykin vastly improves the electron microscope	1939
Scientists confirm that chromosomes are made of DNA	1940's
Ernst Mayer of Harvard University proposes "biological species concept"	1942
Barbara McClintock discovers "jumping genes"	1947
*Maurice Wilkins and Rosalind Franklin take first X-ray pictures of DNA	1952
Jonas Salk develops polio vaccine	1952
Stanley Miller & Harold Urey test Oparin's Theory	1953
*James Watson and Francis Crick postulate the structure of DNA, proposing double helix model	1953
Alfred Hershey and Martha Chase prove that genes are made of DNA	1958
Sidney Fox demonstrates spontaneous organization of amino acids into microspheres	1958
***Robert Whitaker adds 5th Kingdom, Fungi**	1969
Lynn Margulis, a biologist at University of Massachusetts at Amherst, proposes Endosymbiont Theory	early 1970's
First time a specific piece of DNA could be isolated in a chromosome	1973
Viking Landers I & II touch down on Mars	1976

***Carl Woese, of University of Illinois, uses ribosomal RNA (rRNA) to show evolutionary relationships among organisms; proposes new classification system, using domains of Archaea, Prokaryota and Eukaryota**	1977
Method developed to allow the nucleotide sequence of DNA fragments to be isolated	1978
DNA fingerprinting protocol established by Alec Jeffreys	1984
*Invention of DNA polymerase chain reaction (PCR) method of gene isolation by Kary Mullis	1988
*Scanning Electron Microscope reveals structure of molecule	1988
Human Genome Project is launched	1990
DNA used to classify birds	1992
***T.D. Brock uses ribosomal RNA sequencing to revise phylogenetic tree**	1994
Discovery of evidence of <u>possible</u> fossilized life in Mars meteorite by David S. McKay, et al.	1996
***Classification system changes from five Kingdoms to six, with acknowledgement of many types of unicellular Archaea that can live in extreme conditions**	1997
Ultra-High Resolution Scanning **S**uperconducting **Qu**antum **I**nterference **D**evice microscope developed by Franz Baudenbacher	2000
Benjamin Weiss, Francis Macdonald & Joseph Kirschvink, using the S.Q.U.I.D. microscope, demonstrate that Martian meteorite ALH84001, during its formation & transit to Earth, never exceeded temperatures required for biogenic processes	2000
Human Genome Project	2000 and on

Suggested Internet Resources:

www.utmem.edu/personal/thjones/hist/hist_mic.html

www.dmoz.org/Science/Biology/History/

www.discoveryschool.com

http://biology.clc.uc.edu/courses/bio104/hist_sci.html

www.zoologie.biologie.de/history.html

www.cshl.org

www.accessexcellence.org/AB/BC#anchor-35326

www.ucmp.berkeley.edu/help/topic/history.html

http://dir.yahoo.com/science/index.html

http://www.sidwell.edu/us/science/vlb5/Labs/Classicication_Lab

www.supercharge.org/sciencemath/science.html

www.scicentral.com/

www.BioChemlinks.com

http://www.asap.unimelb.edu.au/hstm/htsm_biographical.htm

www.sciencetimeline.net/siteindex.htm

www.botany.hawaii.edu/faculty/wong/BOT135/Lect04_b.htm

http://www.ornl.gov/hgmis/

STUDENT SHEET

TIME FOR A CHANGE

Topic:

Year of Discovery (or year invented):

Sources (minimum of four) -
Websites:

Books or periodicals (Give title, author, publisher, copyright date, and page numbers cited):

Description of discovery or invention (25 min./100 word max.):

Importance of discovery or invention to Biology (25 min./100 word max.):